ENERGY AUDIT, ANALYSIS, AND RECOMMENDATIONS REPORT

JENKINS PLANTATION

GREEN BOTTOM, WEST VIRGINIA

Performed by West Virginia Weatherization Assistance Program

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Energy Audit, Analysis, and Recommendations Report

Jenkins Plantation
Green Bottom, West Virginia

Introduction

The Jenkins Plantation house was originally built in 1835. It is a two-story brick house with a full basement that has undergone several renovations over its history. Greg Miller, caretaker/tour guide of the house, advised us that there are tentative plans for restoration of the home to its original condition. This was a key point in our evaluation of the house.

Mr. Miller stated that the addition to the home, currently being used as the kitchen, office space, and garage, would be torn down, as it was not part of the original structure. The door between the rest of the house and the addition would be bricked over. Our evaluation, therefore, did not consider the addition.

Mr. Miller stated the house was very expensive to heat. Because propane is a non-metered fuel, we did not enter fuel bills into the audit for analysis.

The anticipated restoration and the uncertainty over exactly what retrofits would be compatible with the historic preservation of the house influence the analysis and recommendations found herein. The U.S. Department of Energy (DOE) National Energy Audit (NEAT) is the audit tool used by the West Virginia Weatherization Assistance Program. NEAT was designed for the Department of Energy and the Weatherization Assistance Program by Oak Ridge National Laboratory. It apples engineering and economic calculations to evaluate and recommend energy conservation measures. A copy of the NEAT report is enclosed.

Any energy audit tool, including NEAT, is limited by potential stringent historic preservation requirements, and therefore requires additional explanation of its calculations. The narrative of this report attempts to give recommendations for energy conservation retrofits to be considered during the tentative restoration of the house.

1. Health and Safety Considerations

There are three 90+ propane gas furnaces. Each is connected to a heat pump and is zoned for a different section of the house. One is in the garage and is zoned for the addition, which presumably will be removed. The 90+ furnaces are closed combustion units and therefore should not present any indoor air quality concerns, either from toxic gases or moisture. Filters should be cleaned and/or replaced when needed. Depending on frequency of use, heating system cleanings and tune-ups should be performed on a consistent basis.

Although the house is located in a wetlands area, there was little evidence of moisture problems in the structure. There was a dehumidifier in the basement, leading us to believe there is some dampness. Part of the reason there was little sign of any moisture damage can be attributed to the high air infiltration rate of the house, and subsequent dissipation of the moisture. If the house is air sealed, as will be recommended, the moisture will not be removed as much by natural air movement and can become a greater concern.

2. Heating System Efficiency Analysis

The 90+ furnaces with connected heat pumps should be an efficient heating and cooling system for the house. We only recommend periodic maintenance cleanings, tune-ups, and filter replacements as mentioned above. Since the house is unoccupied so much of the time, the thermostat settings should be turned down in winter to a minimum setting to prevent freezing and turned off in summer when the house is not occupied. The caretaker of the house should make these frequent thermostat adjustments. If desired, programmable "smart' thermostats could be installed.

3. Duct System Analysis

We performed a taped duct test to test the leakiness of the duct work. To perform the test, first we measured the air infiltration rate of the entire house with the ducts open. We then sealed all duct registers on the first floor and retested. Then we sealed all second floor registers (leaving the first floor registers sealed as well) and tested again. There was no significant infiltration rate reduction by sealing the duct registers on either floor. If there had been significant duct leakage problems, a noticeable reduction would have been seen. We still recommend sealing all visible cracks or gaps in the supply and return duct system with fibered tape and mastic, in particular the cracks under the registers where the ductwork is attached to the floor (downstairs) and ceiling (upstairs).

The rigid ductwork in the basement should be insulated when the restoration happens. It was our understanding that the ductwork would be hidden during the restoration making the insulation possible. The flex duct in the attic is insulated sufficiently.

4. Air Infiltration

Blower door tests revealed exceedingly high air infiltration rates of 7150 CFM_{50}. We recommend a level for this house of 2500 CFM_{50}. 2500 CFM_{50} is a higher infiltration level than normally advised for a house this size, but would provide significant energy savings while helping to insure against potential moisture problems. The rate is achievable during the retrofit if the contractor is thinking in terms of stopping air infiltration. For instance, any hole drilled for pipes or wiring should be sealed after the installation.

A lot of the existing air infiltration is from the basement. The basement of the house is a semi-conditioned space. The furnace and ductwork for the first story are in the basement. The wooden floor of the first story has numerous cracks creating significant air movement between the basement and the rest of the house. As a case in point, there was no difference in the air infiltration rate of the entire house when the door between the first floor and basement was open. This leads to the conclusion that all air infiltrating into the basement was also infiltrating freely into the rest of the house.

There were several cracks and holes into the basement. The windows on the south side of the basement (front of house) were leaking. There was a very large hole above the cold air return on the same wall. There were several other smaller gaps around the perimeter of the house, mainly in the foundation stones and where intentional openings for wiring, plumbing, and other mechanical systems were not properly sealed. All such holes should be sealed. Also, any gaps between the basement and exterior and interior wall cavities should be sealed. Such gaps create stack effect, similar to a chimney, and draw conditioned air from the living space.

Fireplaces were another serious location of air movement. Attempts to seal fireplace openings were not successful, as the blower door showed significant air leakage from these sources. The stack effect of these fireplaces forces a lot of heated air out of the house. If the fireplaces are not going to be used, they should be permanently sealed. To best accomplish this, they should be sealed at the top of the chimneys with concrete or mortar, and at each fireplace opening in the house. If permanent sealing is not an option, then we recommend using inflatable fireplace seals, such as the Draft Stopper, that conform to the shape of the opening at the start of the flue right above the visible part of the fireplace. These can be removed if the fireplace is to be used.

An infrared scan of the walls showed some air movement between the layers of bricks in the walls. Because of the construction of the house, densepack wall insulation or any other practical wall insulation is not possible. Any gap in the interior wall envelope should be sealed. Likewise, any crack in the exterior should also be sealed. When the basement ceiling is removed during the restoration, any gaps between the basement and exterior wall cavities (there are supposedly three layers of bricks) should be sealed with an impermeable air barrier, such as foam or caulk. If possible, similar gaps should be sealed at the tops of the cavities from the attic. This may not be possible due to the limited access to these areas and the fact that there is some blown insulation in the attic.

The door between the second story and the attic is also a significant source of air leakage. Its treatment depends on its status in the context of its historic value. It is poor fitting in the opening and has holes in it as well.

The high air infiltration rate is the one most significant energy problems in the house. For optimum benefit, the contractor doing the restoration should be fully aware of these problems and, for best results, utilize a blower door intermittently during the work to gauge the progress of the air sealing. NEAT projections show potential savings of approximately $500 per year, based on propane costs of $1.64 a gallon and air infiltration reduction of 7150 CFM_{50} to 2500 CFM_{50}.

5. Insulation

The attic has about 6 inches of blown cellulose beneath the attic floor between the ceiling joists. Its coverage was surprisingly thorough and uniform. Approximately four inches of additional insulation could be blown into the cavities, as the joists are 10" depth. We would recommend tubing additional cellulose at high pressure to achieve maximum R-value and to help reduce air leakage into the attic. Stopping air leakage into the attic by any other means would be difficult as the leakage sites are covered with insulation (which is currently acting more as a filter than an air barrier) and the flooring. The partial densepack will reduce air leakage as much as possible for this situation.

The stairs between the second story and the attic create a large opening that breaks the thermal barrier between the attic and living space. We recommend the top of the stairway be insulated to the same R-value as the rest of the attic using rigid Styrofoam or polystyrene board. This large hatch cover should fit tightly over the stairway frame, air sealing between the stairway and attic. This treatment would greatly diminish the negative effects of the poor fitting door leading to the stairway described above. The hatch cover, made of rigid foam board, would be light enough to easily move when access to the attic is necessary.

Because of the construction of the walls, with three layers of bricks and very little spacing between the layers, adding insulation would be impractical and nearly impossible. If the restoration were to include new interior walls, then insulation could be added. We were lead to believe this would probably not be the case.

The basement ceiling is incomplete. Mr. Miller stated that the basement ceiling would be removed and then reinstalled appropriately for the historic restoration. We recommend installing an impermeable air barrier under the first story flooring at this time, and then installing R-19 fiberglass in the joist cavities. The ceiling should then be installed. NEAT cited this measure as having the second largest potential for energy savings.

6. Windows

There are nine large windows (40 X 80) on both the front and back of the house. In addition there are basement windows and some stationary windows around the front and rear doors. Blower door tests showed surprisingly little air leakage around the windows. The basement windows were the leakiest. The infrared camera showed some heat loss from the large main windows. Because of the large number of these windows (18 total) and their large surface area (approximately 400 square feet), the windows are likely more problematic because of thermal loss than infiltration.

NEAT calls for the addition of storm windows for all the windows. If low-e replacement windows can be installed for around $140 or less (doubtful for this size window), NEAT calls for their installation on the North wall. With the historic preservation of the house, it is doubtful this treatment will be done, as, at a minimum, all windows would seemingly be treated the same. We do not know if window replacement or storm windows are a viable option because of the status of the house. At a minimum, we recommend reglazing any loose lites and tightening up any loose sashes. This can be done, if allowable, by weatherstripping or vinyl or aluminum replacement channels. Heavy curtains can also cut back on heat loss.

7. Doors

The doors have similarities to the windows but much less surface area. NEAT does not call for replacement doors. While there may be some heat loss through the thin wooden panels, replacement from strictly an energy conservation standpoint is not cost-effective. Dependent on the restoration requirements, we recommend that exterior doors and the doors leading to the basement and attic be weatherstripped and have a threshold added. As mentioned above, the door to the attic is probably too poor fitting for this simple retrofit. If the doors are to be replaced in the restoration, we recommend well-insulated doors. Any side lites should be reglazed and caulked where necessary.

8. Electric Baseload Measures

We metered the refrigerator for electric usage and estimate its yearly operational costs to be less than $30 making any replacement non cost-effective. The water heater (which was in the garage) was insulated to R 8.3. It did not appear that the shower was used with any degree of regularity. There was no dishwasher. With its current very low demand for hot water, the water heater is more than adequate. The thermostat should be turned down to 120 degrees or less, if possible. The water heater can also be put on a 30-amp switch and turned off when no hot water will be needed. This could be several days a week. Any hot water pipes that can be accessed should be insulated. Any cold water pipes subject to freezing should also be insulated.

Due to the low occupancy time of the house, no lighting retrofits are called for. We recommend replacing any incandescent bulb that is on more than 4 hours a day with a compact fluorescent.

Summary

The anticipated restoration and the uncertainty over exactly what retrofits would be compatible with the historic preservation of the house somewhat clouds the exact prescription of measures to recommend to make the Jenkins Plantation more energy efficient. We strongly recommend that energy considerations be considered at the forefront during any planning and negotiations with funding sources and contractors. The following recommendations, based on the NEAT audit, diagnostic tests, and visual observation, are meant to summarize and prioritize the energy conservation needs of the house that should be addressed with restoration. Please refer to the appropriate section of the report for a fuller description of the summarized measures.

1. Address air infiltration issues, including penetrations into the basement, sealing of the fireplaces and chimneys, stopping free air movement between the basement and first floor living area, and sealing door between second story and attic.

2. Insure thermostat settings are adjusted when the house is unoccupied.

3. Insulate accessible rigid ducts in basement.

4. Insulate under the first story floor (basement ceiling).

5. Address windows by whatever means possible within historic preservation guidelines.

6. Insulate top of attic stairway with rigid foam board and add densely packed cellulose to existing attic insulation.

National Energy Audit Tool (NEAT) Output Report

Agency	WV WAP
Job	Historic Home 1
AuditDate	3/29/01
RunID	986398453
ClientName	Jenkins Plantation
Auditor	Bob Scott, Rich Courtney
WeatherFile	CHARTNWV.WX
ParamName	Standard
Comment	Basement is a semi-conditioned area, but is not included in living space area. The add-on room i

Annual Energy and Cost Savings

Index	Recommended Measure	Components	Heating (MBtu)	Heating ($)	Cooling (kWh)	Cooling ($)	Total (MBtu)
0	Infiltration Redctn		28.1	499	184	11	28.0
1	Duct Insulation		4.2	76	76	5	4.0
2	Floor Ins. R-19	F1	17.0	303	-99	-6	16.0
3	DWH Tank Insulation		0.0	0	0	0	0.0
4	Storm Windows	Nor,Sou	12.5	222	153	9	13.0

Energy Saving Measure Economics

Index	Recommended Measure	Components	Measure Savings ($/yr)	Measure Cost ($)	Measure SIR	Cummulative Cost ($)	Cummulative SIR
0	Infiltration Redctn		510	250	17.2	250	17.0
1	Duct Insulation		80	120	9.6	370	14.0
2	Floor Ins. R-19	F1	297	718	6.0	1088	8.0
3	DWH Tank Insulation		11	15	5.6	1103	8.0
4	Storm Windows	Nor,Sou	231	1800	1.5	2903	4.0

Materials

Index	Material	Type	Quantity	Units
0	Floor Insulation	Faced Batt - R-19	1139	Sqft
1	Duct Insulation		80	Sqft
2	Storm Window		18	Each
3	DHW Tank Insulatio		1	Each

Pre/Post Retrofit Energy and Loads

	Pre Retrofit		Post Retrofit	
	Heating	Cooling	Heating	Cooling
Annual load (MBtu/yr)	123.9	29.1	74.6	27.2
Annual Energy (MBtu/yr)	144.9	12.4	87.3	11.6
Heat loss (kBtu/hr)	124.7	0.0	100.9	0.0
Output required (kBtu/hr)	149.6	0.0	116.1	0.0

Approximate Manual J Component Contributions to Peak Heating Load

Component Type	*Component Name*	*Area or Volume (Inf)*	*Pre Retrofit Load (Btu/h)*	*Post Retrofit Load (BTU/h)*
Wall	N3	869	21901.4	21901.4
Wall	S1	879	22159.2	22159.2
Wall	W2	494	12448.8	12448.8
Wall	W4	474	11944.8	11944.8
Window	n3f	3	201.4	201.4
Window	n3s	3	213.1	213.1
Window	Nor	164	10244.3	4915.2
Window	S1s	3	213.1	213.1
Window	Sou	164	10244.3	4915.2
Door	E4	20	384.3	384.3
Door	N3	24	695.5	695.5
Door	S1	17	492.7	492.7
Attic	A1	1139	3858.6	3858.6
Foundation	F1	1139	8791.6	1859.0
Infiltration	Inf	18224	20860.3	14734.1
Total heat loss	Tot	0	124653.4	100936.4
Duct loss	Duct	0	24930.7	15140.5
Output required	Output	0	149584.1	116076.8

Special Notes

0 NOTE: Heat loss and Output required are only guides to sizing equipment.
1 NOTE: See NEAT User's Manual for further sizing details.
2 NOTE: Read cautions in NEAT User's Manual related to sizing results.